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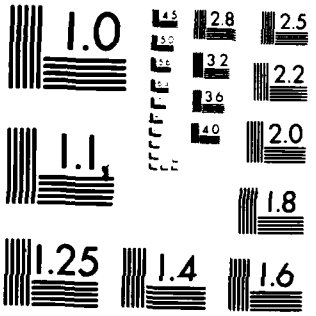

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FOREIGN TECHNOLOGY DIVISION

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by

Zbigniew Hoffman and F.W. Lewczanowski

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TYPE KODEK DC MODEMS FOR USE IN CYFRONET TERMINAL NETWORK

Zbigniew Hoffman and F. W. Lewczanowski

Most large scientific institutes are presently equipped with powerful computing centers. Frequently terminals are connected to the central computer, which are located in scientific laboratories and facilitate direct access to a computer for scientists. Terminals can also be installed in other institutions which want to take advantage of the computing power of the center, its library of programs, and experience. Terminals installed at great distances from the central computer are connected to the network by means of telecommunication lines and standard modems manufactured and supplied by industry.

Modems are adapted to operate in the frequency range 300-3400 Hz, i.e., the frequency band occupied by one telephone channel. Modern modems, intended for synchronous operation at a 2400 bit/s and 4800 bit/s rate are usually based on phase modulation, while for a 9600 bit/s transmission rate not only multivalued phase modulation but in addition amplitude modulation must be used. To adapt modems to various cable section lengths, various cable characteristics and temperature changes requires equipping them with complex correctors and also automatic control systems. The characteristics of modems described above, as well as the analog technology in which they are usually realized, influence their high price, which may vary between 2000 to 12,000 dollars.

The expansion of local terminal networks does not require expensive modems (300 to 3400 Hz band intended for operation on telephone lines). The domestic industry, and until recently foreign manufacturers, did not manufacture simple

type modems. In 1972 some foreign centers, for example, CERN (Switzerland), developed inexpensive modems intended for local operation.

The CYFRONET Environmental Computing Center, with headquarters in Swierk, is providing users in Warsaw with computing power via ASR-390 asynchronous terminals and type LSBT-731 synchronous terminals. Terminals in Warsaw are connected to the central CYBER-73 computer in Swierk via carrier current channels with transmission band 300-3400 Hz. The absence of a constant component and limitation of the transmission band to the range of higher frequencies necessitates the use of modems both in Swierk and by the users in Warsaw. Along with servicing external users, CYFRONET provides a considerable portion of its computing power to satisfy the needs of the Nuclear Research Institute in Swierk. Besides direct access to a computer, scientists in the Nuclear Research Institute can also take advantage of terminals installed in Swierk. A further increase in the number of terminals is planned in such objects as the Maria reactor, the Eva reactor, the linear accelerator, and the physics building by installing in them terminals based on a minicomputer.

The United Nuclear Research Institute in Dubna is also setting up a network of terminals connected to the CDC 6200 computer. Therefore both scientific organizations were interested in the development of inexpensive and simple dc modems for asynchronous and synchronous data transmission.

As a result of an agreement, the CYFRONET Center developed, in collaboration with the Unified Nuclear Research Institute, a series of type KODEK DC modems intended for operation in local terminal networks. This project was also undertaken in view of the lack of any prospects of obtaining such equipment from industry in the near future.

KODEK is a device which allows one to connect to the computer an asynchronous or synchronous terminal via a telephone line with twisted pairs. This device can be used in terminal networks, when the distance of the terminal from the computer does not exceed several kilometers and the frequency band transmitted over the telephone line is not limited to the 300-3400 Hz range. KODEK is equipped with a

standard V-24 interface. An example of utilization of a KODEK device is illustrated in Fig. 1.

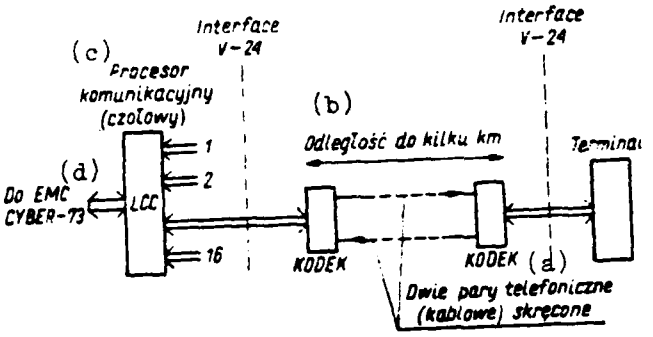

Fig. 1. Connection of terminal to central computer via KODEK device

Key: a. Two twisted (telephone cable) pairs
b. Distance to several km
c. Communication processor (front)
d. to CYBER-73 computer

The CYFRONET Center developed three types of KODEK devices, two of which will be described in greater detail.

KODEK 1 -- DC Modem for Asynchronous Data Transmission

KODEK 1 is a simple and inexpensive device which makes it possible to connect to the central computer terminals operating in a start-stop system (for example, ASR-390) equipped with a V-24 interface. A block diagram of KODEK 1 is presented in Fig. 2.

The TxDATA signal generated by a computer or terminal (according to CCITT recommendations for the V-24 interface) is converted to a TTL level signal, and

subsequently transmitted via the transmission line receiver over a telephone line as a bipolar signal with amplitude ±200 mV. The low levels of the signal transmitted to the transmission line are the result of possible interference of other analog circuits and defined by the corresponding specifications. The difference data signal on the receiving side is amplified in the transmission line receiver and first converted to a standard TTL signal and next to a CCITT signal and received by a computer or terminal as a RxDATA signal.

The remaining signals at the V-24 interface are used in the form of a constant level signal. KODEK 1 can operate at any data transmission rate, which is always determined by the computer. The installed OPERATION-LOOP switch facilitates fast identification, which element of the network -- computer, KODEK (line), terminal -- was damaged. The state of the signals TxDATA, RxDATA, and LOOP is displayed on the front panel for fast location of an error in the KODEK device proper.

KODEK 1 is equipped with a 220^{+10}_{-15} V, 50 Hz, 10 VA supply unit.

KODEK 2 -- DC Model for Synchronous Data Transmission

KODEK 2 is a device which makes it possible to connect to the central computer a terminal operating in a synchronous system (for example, LSBT-731 or PDP-11). Fig. 3 presents the block diagram of KODEK 2.

The TxDATA signal generated by a computer or terminal is received by KODEK 2 in TxCLOCK signal timing. After it passes the TTL/CCITT signal level converter, the TxDATA signal is transmitted to the frequency modulator, which generates a rectangular wave whose frequency depends on the TxDATA signal. If a rectangular wave with frequency f is transmitted for the TxDATA "0" signal, for a "1" signal this frequency is 2f. The carrier wave generated by the local quartz generator (CLOCK) is transmitted to the modulator. The modulated data signal is sent via the transmitter to the telephone line in the form of a rectangular wave difference signal with variable frequency and low transmission level (±200 mV).

The difference frequency modulated RxDATA signal arriving from the telephone line is amplified in the transmission line receiver and converted to TTL levels

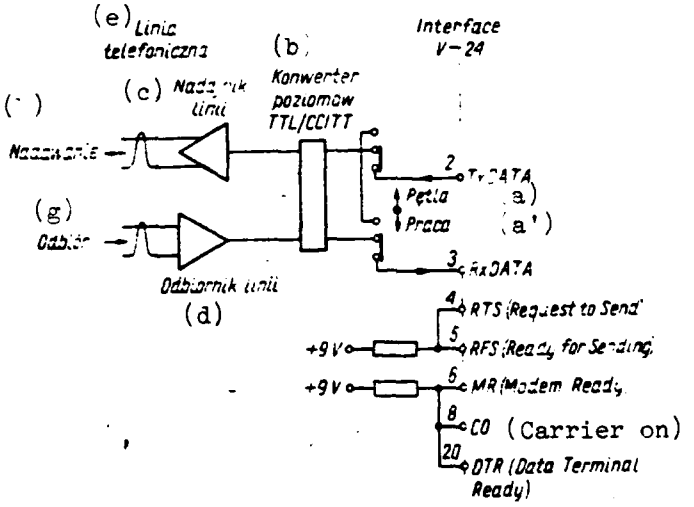

Fig. 2. KODEK 1 block diagram

Key: a. Loop
a', Operation
b, TTL/CCITT signal level converter
c. Transmission line transmitter
d. Transmission line receiver
e. Telephone line
f. Transmission
g. Reception

and subsequently transmitted to the frequency demodulator. Using a local carrier wave generator, the demodulator isolates from the modulated wave the RxDATA signal and the RxCLOCK synchronization signal. The process of obtaining the data and synchronization signal in the demodulator as well as the modulation process described above is based on digital techniques and illustrated in a simplified manner in Fig. 4. This ensures great simplicity of systems, operational reliability, and low cost of the device.

Unlike the modem described before, KODEK requires for proper interaction with the computer or terminal generation of a train of control signals. In the presence of a DTR signal at the V-24 interface, the RTS signal causes generation of the RFS

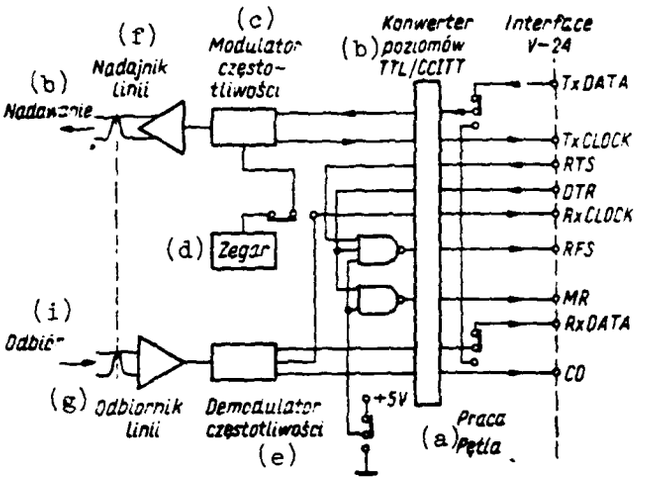

Fig. 3. KODEK 2 block diagram

Key: a. Operation a'. Loop
b. TTL/CCITT signal level converter
c. Frequency modulator
d. Clock
e. Frequency demodulator
f. Transmission line transmitter
g. Transmission line receiver
h. Transmission
i. Reception

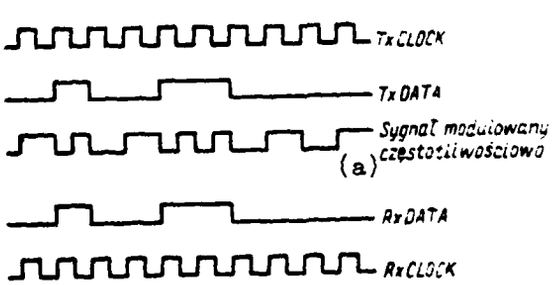

Fig. 4. Modulation and demodulation of signal

Key: a. Frequency modulated signal

signal. The DTR signal also allows one to generate the MR signal. The presence of a signal at the input of the transmission line receiver brings about transmission of the CO signal to the V-24 interface.

KODEK 2 is designed to operate at three data transmission rates: 2400 bit/s, 4800 bit/s, and 9600 bit/s. Simple switching over makes it possible to operate also at a 48,000 bit/s transmission rate. The data transmission rate is always determined by KODEK 2. The OPERATION-LOOP switch makes it possible to form a loop on the side of the V-24 interface by connecting TxDATA and RxDATA and simultaneously disconnecting MR, RFS control signals and switching over TxCLOCK to ensure proper synchronization with incoming data.

KODEK 2 is equipped with a 220^{+10}_{-15} V, 50 Hz, 15 VA supply unit.

Besides the types KODEK 1 and KODEK 2 DC modems described above, the CYFRONET Center developed another type of modem intended for connection to terminals located in the same building as the central computer. However, the cost of such a modem does not differ substantially from the cost of KODEK 2, which is why wider use of the latter is not envisioned.

The KODEK devices developed and built in CYFRONET make the development of a local terminal network independent of foreign suppliers. The three types of modems have been operational in the CYFRONET network since mid-1975. Some of these modems are operating in the Warsaw Postal Network. Although no provisions were made for galvanic separation of the input and output in these modems, no negative effect resulting from the latter have been observed.

The devices described above can be used in all terminal networks in which the base band is transmitted over telephone lines. In cases when galvanic separation of the input from the output is required, insulation via capacitors can be used for synchronous data transmission. Suitable tests were made on the KODEK 2 device.

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